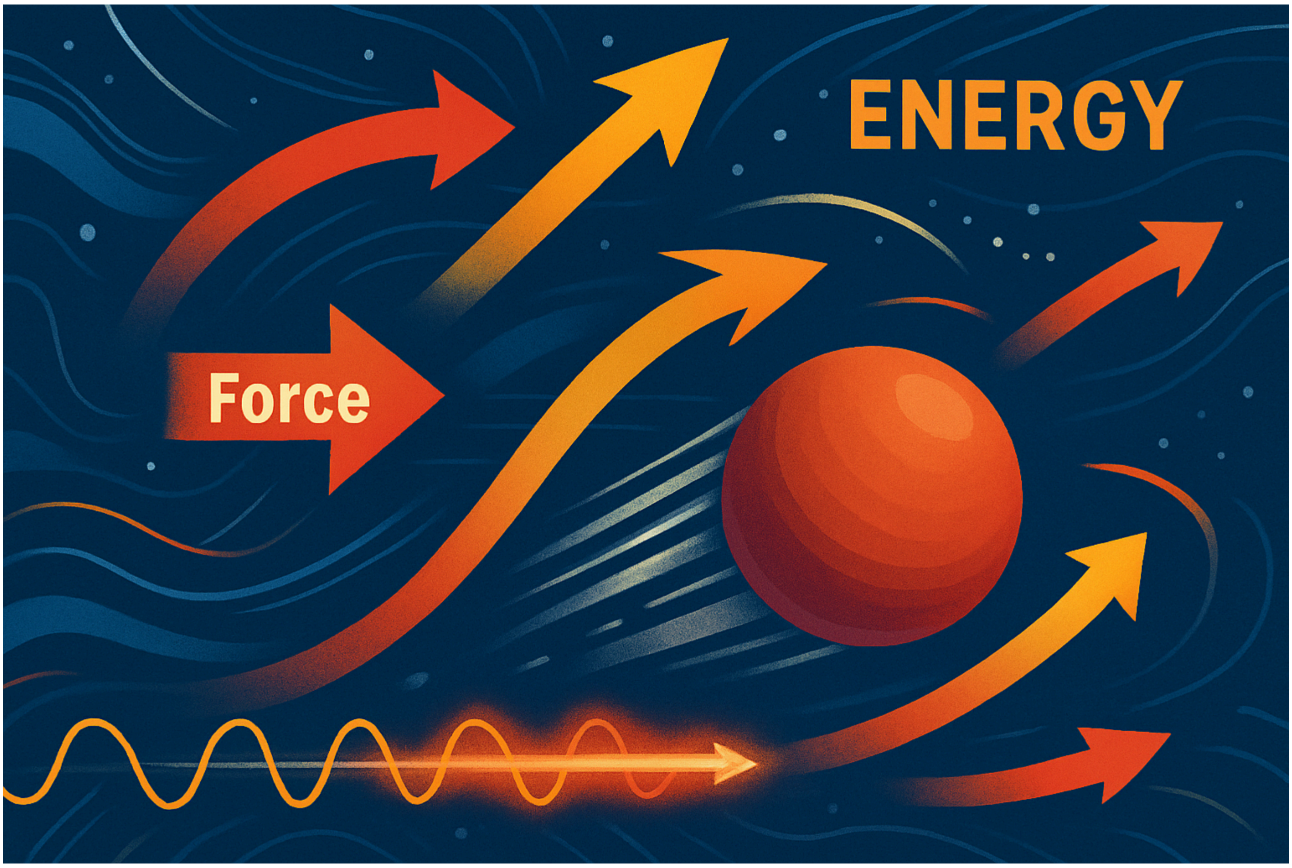
IGCSE Physics: Motion, forces and energy

Syllabus Code: 0625



Learning Objectives

1.1 Physical quantities and measurement techniques

- Describe the use of rulers and measuring cylinders to find a length or a volume
- Describe how to measure a variety of time intervals using clocks and digital timers
- Determine an average value for a small distance and for a short interval of time by measuring multiples (including the period of oscillation of a pendulum)
- Understand that a scalar quantity has magnitude (size) only and that a vector quantity has magnitude and direction

- Know that the following quantities are scalars: distance, speed, time, mass, energy and temperature
- Know that the following quantities are vectors: force, weight, velocity, acceleration, momentum, electric field strength and gravitational field strength
- Determine, by calculation or graphically, the resultant of two vectors at right angles, limited to forces or velocities only

1.2 Motion

- Define speed as distance travelled per unit time; recall and use the equation $v = s/t$
- Define velocity as speed in a given direction
- Recall and use the equation average speed = total distance travelled / total time taken
- Sketch, plot and interpret distance–time and speed–time graphs
- Determine, qualitatively, from given data or the shape of a distance–time graph or speed–time graph when an object is: (a) at rest, (b) moving with constant speed, (c) accelerating, (d) decelerating
- Define acceleration as change in velocity per unit time; recall and use the equation $a = \Delta v/\Delta t$
- Determine from given data or the shape of a speed–time graph when an object is moving with: (a) constant acceleration, (b) changing acceleration
- Calculate speed from the gradient of a straight-line section of a distance–time graph
- Calculate acceleration from the gradient of a speed–time graph
- Calculate the area under a speed–time graph to determine the distance travelled for motion with constant speed or constant acceleration
- Know that a deceleration is a negative acceleration and use this in calculations
- State that the acceleration of free fall g for an object near to the surface of the Earth is approximately constant and is approximately $9.8\ m/s^2$
- Describe the motion of objects falling in a uniform gravitational field with and without air/liquid resistance, including reference to terminal velocity

1.3 Mass and weight

- State that mass is a measure of the quantity of matter in an object at rest relative to the observer
- State that weight is a gravitational force on an object that has mass
- Define gravitational field strength as force per unit mass; recall and use the equation $g = W/m$ and know that this is equivalent to the acceleration of free fall
- Know that weights (and masses) may be compared using a balance
- Describe, and use the concept of, weight as the effect of a gravitational field on a mass

1.4 Density

- Define density as mass per unit volume; recall and use the equation $\rho = m/V$
- Describe how to determine the density of a liquid, of a regularly shaped solid and of an irregularly shaped solid which sinks in a liquid (volume by displacement), including appropriate calculations
- Determine whether an object floats based on density data
- Determine whether one liquid will float on another liquid based on density data given that the liquids do not mix

1.5 Forces

1.5.1 Effects of forces

- Know that forces may produce changes in the size and shape of an object
- Define the spring constant as force per unit extension; recall and use the equation $k = F/x$
- Sketch, plot and interpret load–extension graphs for an elastic solid and describe the associated experimental procedures
- Define and use the term ‘limit of proportionality’ for a load–extension graph and identify this point on the graph (an understanding of the elastic limit is not required)
- Determine the resultant of two or more forces acting along the same straight line

- Recall and use the equation $F = ma$ and know that the force and the acceleration are in the same direction

1.6 Momentum

- Define momentum as mass × velocity; recall and use the equation $p = mv$
- Define impulse as force × time for which force acts; recall and use the equation impulse = $F\Delta t = \Delta(mv)$
- Apply the principle of the conservation of momentum to solve simple problems in one dimension
- Define resultant force as the change in momentum per unit time; recall and use the equation $F = \Delta p/\Delta t$

1.7 Energy, work and power

1.7.1 Energy

- State that energy may be stored as kinetic, gravitational potential, chemical, elastic (strain), nuclear, electrostatic and internal (thermal)
- Describe how energy is transferred between stores during events and processes, including examples of transfer by forces (mechanical work done), electrical currents (electrical work done), heating, and by electromagnetic, sound and other waves
- Recall and use the equation for kinetic energy $E_k = 1/2\ mv^2$
- Recall and use the equation for the change in gravitational potential energy $\Delta E_p = mg\Delta h$
- Know the principle of the conservation of energy and apply this principle to simple examples including the interpretation of simple flow diagrams
- Know the principle of the conservation of energy and apply this principle to complex examples involving multiple stages, including the interpretation of Sankey diagrams

1.7.2 Work

- Understand that mechanical or electrical work done is equal to the energy transferred

- Recall and use the equation for mechanical working $W = Fd = \Delta E$

1.7.3 Energy resources

- Describe how useful energy may be obtained, or electrical power generated, from: (a) chemical energy stored in fossil fuels, (b) chemical energy stored in biofuels, (c) water, including the energy stored in waves, in tides and in water behind hydroelectric dams, (d) geothermal resources, (e) nuclear fuel, (f) light from the Sun to generate electrical power (solar cells), (g) infrared and other electromagnetic waves from the Sun to heat water (solar panels) and be the source of wind energy, including references to a boiler, turbine and generator where they are used
- Describe advantages and disadvantages of each method in terms of renewability, availability, reliability, scale and environmental impact
- Know that radiation from the Sun is the main source of energy for all our energy resources except geothermal, nuclear and tidal
- Know that energy is released by nuclear fusion in the Sun
- Know that research is being carried out to investigate how energy released by nuclear fusion can be used to produce electrical energy on a large scale
- Understand, qualitatively, the concept of efficiency of energy transfer
- Define efficiency as: (a) (%) efficiency = (useful energy output / total energy input) ($\times$ 100%), (b) (%) efficiency = (useful power output / total power input) ($\times$ 100%); recall and use these equations

1.7.4 Power

- Define power as work done per unit time and also as energy transferred per unit time; recall and use the equations (a) $P = W/t$, (b) $P = \Delta E/t$

1.8 Pressure

- Define pressure as force per unit area; recall and use the equation $p = F/A$
- Describe how pressure varies with force and area in the context of everyday examples
- Describe, qualitatively, how the pressure beneath the surface of a liquid changes with depth and density of the liquid

- Recall and use the equation for the change in pressure beneath the surface of a liquid $\Delta p = \rho g \Delta h$

Core Content

1.1 Physical quantities and measurement techniques

Definitions

- **Scalar Quantity:** A physical quantity that has magnitude only (e.g., distance, speed, time, mass, energy, temperature).
- **Vector Quantity:** A physical quantity that has both magnitude and direction (e.g., force, weight, velocity, acceleration, momentum, electric field strength, gravitational field strength).

Measurement Techniques

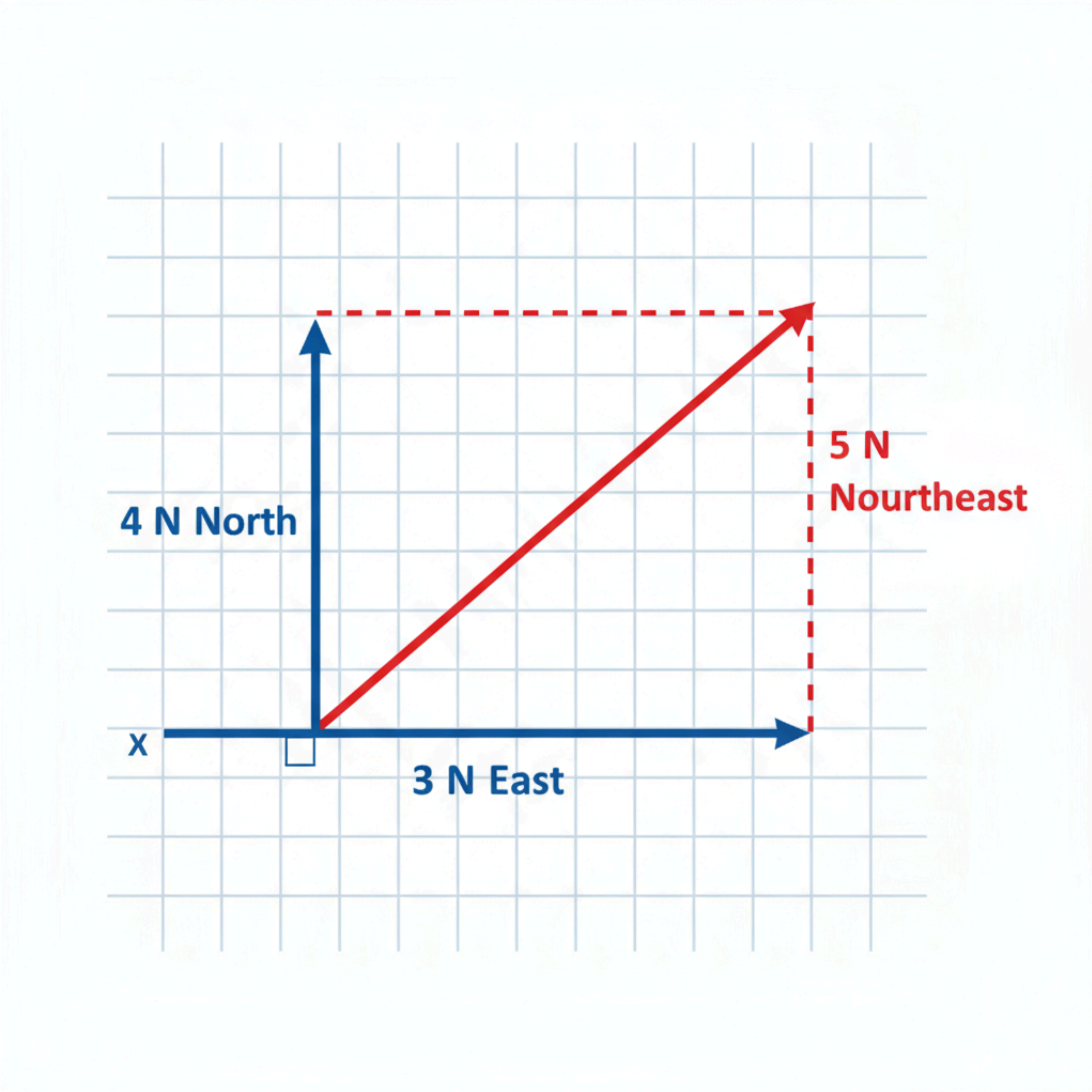
- **Length:** Measured using rulers (for shorter lengths) or measuring tapes (for longer lengths). Precision depends on the smallest division on the scale.
- **Volume:** For liquids, measuring cylinders are used. For regularly shaped solids, calculate using dimensions (e.g., V = lwh for a cuboid). For irregularly shaped solids, use the displacement method with a measuring cylinder.
- **Time:** Measured using clocks, stopwatches, or digital timers. For short intervals or periods of oscillation, multiple measurements can be taken and averaged to reduce human reaction time errors.

Resultant of Vectors

When two vectors (like forces or velocities) act at right angles, their resultant can be found using the Pythagorean theorem and trigonometry.

Formula: For two perpendicular vectors A and B, the resultant R is given by $R = \sqrt{A^2 + B^2}$. The direction can be found using $\tan\theta = B/A$.

Worked Example: Two forces, 3 N east and 4 N north, act on an object. Find the resultant force. * Magnitude: $R = \sqrt{3^2 + 4^2} = \sqrt{9 + 16} = \sqrt{25} = 5N$ * Direction: $\tan\theta = 4/3 \implies \theta = \tan^{-1}(4/3) \approx 53.1^\circ$ North of East.



1.2 Motion

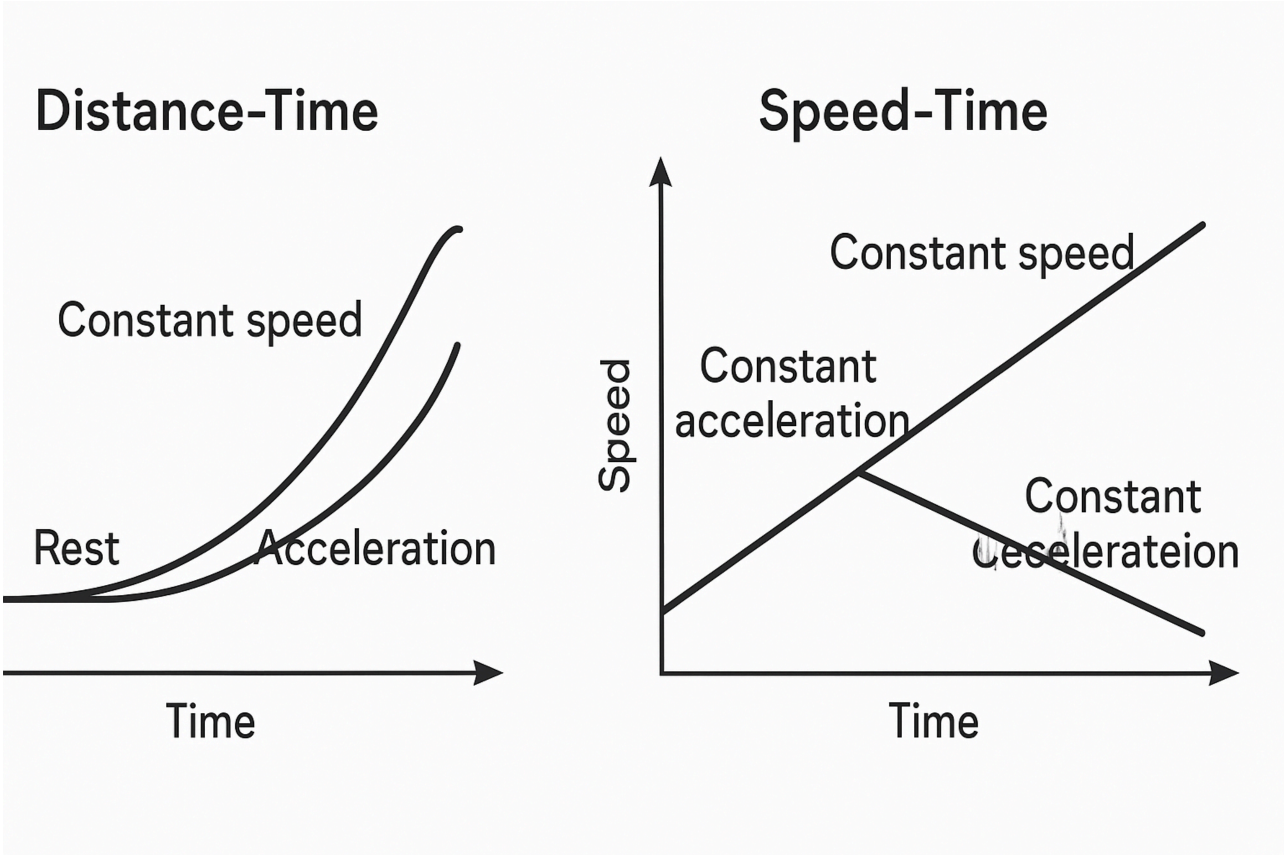
Definitions

- **Speed (v):** The rate at which an object covers distance. It is a scalar quantity. **Formula:** $v = s/t$ (where s = distance, t = time)
- **Velocity (v):** The rate at which an object changes its position. It is a vector quantity, including both speed and direction.
- **Acceleration (a):** The rate of change of velocity. It is a vector quantity. **Formula:** $a = \Delta v/\Delta t$ (where Δv = change in velocity, Δt = change in time)
- **Deceleration:** Negative acceleration, meaning the object is slowing down.

- **Terminal Velocity:** The constant speed that a freely falling object eventually reaches when the resistance of the medium through which it is falling prevents further acceleration.

Graphs of Motion

- **Distance-time graphs:**
    - Horizontal line: Object at rest.
    - Straight line with positive gradient: Constant speed.
    - Curved line: Changing speed (acceleration or deceleration).
    - Gradient of the line = speed.
- **Speed-time graphs:**
    - Horizontal line: Constant speed.
    - Straight line with positive gradient: Constant acceleration.
    - Straight line with negative gradient: Constant deceleration.
    - Curved line: Changing acceleration.
    - Gradient of the line = acceleration.
    - Area under the graph = distance travelled.



Worked Example (Speed-time graph): An object accelerates uniformly from rest to 10 m/s in 5 seconds. It then travels at constant speed for 5 seconds before decelerating uniformly to rest in another 5 seconds. Calculate the total distance travelled. * Plot the graph: A triangle from (0,0) to (5,10), a rectangle from (5,10) to (10,10), and a triangle from (10,10) to (15,0). * Area 1 (acceleration): $0.5 \times 5s \times 10m/s = 25m$ * Area 2 (constant speed): $5s \times 10m/s = 50m$ * Area 3 (deceleration): $0.5 \times 5s \times 10m/s = 25m$ * Total distance = $25m + 50m + 25m = 100m$

Free Fall

- Near the Earth's surface, the acceleration of free fall (g) is approximately constant at 9.8 m/s^2 (often approximated as 10 m/s^2 for simpler calculations).
- Objects falling in a vacuum accelerate uniformly. In air, air resistance opposes motion. As speed increases, air resistance increases until it equals the gravitational force, leading to terminal velocity.

1.3 Mass and weight

Definitions

- **Mass (m):** A measure of the amount of matter in an object. It is a scalar quantity and remains constant regardless of location.
- **Weight (W):** The gravitational force acting on an object due to its mass. It is a vector quantity and depends on the gravitational field strength. **Formula:** $W = mg$ (where m = mass, g = gravitational field strength)
- **Gravitational Field Strength (g):** Force per unit mass. It is equivalent to the acceleration of free fall. **Formula:** $g = W/m$ (measured in N/kg or m/s²)

Comparison of Mass and Weight

Mass is measured using a balance (e.g., beam balance), while weight is measured using a spring balance or newtonmeter.

Analogy: Imagine pushing a shopping cart. The effort to get it moving or stop it relates to its **mass**. The downward pull you feel when lifting it relates to its **weight**.

1.4 Density

Definition

- **Density (ρ):** Mass per unit volume of a substance. It is a scalar quantity. **Formula:** $\rho = m/V$ (where m = mass, V = volume)

Determining Density

- **Liquids:** Measure mass using a balance and volume using a measuring cylinder.
- **Regularly shaped solids:** Measure mass using a balance and dimensions to calculate volume (e.g., length x width x height for a cuboid).
- **Irregularly shaped solids (sinking in liquid):** Measure mass using a balance. Determine volume by the displacement method: immerse the solid in a measuring cylinder containing water and record the change in volume.

Worked Example: A rock has a mass of 150 g. When placed in a measuring cylinder, the water level rises from 50 cm^3 to 100 cm^3. Calculate the density of the rock. * Mass

(m) = 150 g * Volume (V) = 100 cm^3 - 50 cm^3 = 50 cm^3 * Density (ρ) = m/V = 150 g / 50 cm^3 = 3 g/cm^3

Floating and Sinking

- An object floats if its density is less than the density of the fluid it is in.
- An object sinks if its density is greater than the density of the fluid it is in.
- If two immiscible liquids are mixed, the less dense liquid will float on top of the more dense liquid.

1.5 Forces

1.5.1 Effects of forces

Definitions

- **Force (F):** A push or a pull that can change an object's motion, shape, or size. It is a vector quantity.
- **Spring Constant (k):** A measure of the stiffness of a spring, defined as the force per unit extension. **Formula:** $k = F/x$ (where F = force, x = extension)
- **Limit of Proportionality:** The point on a load-extension graph beyond which the extension is no longer directly proportional to the applied load (Hooke's Law no longer applies).

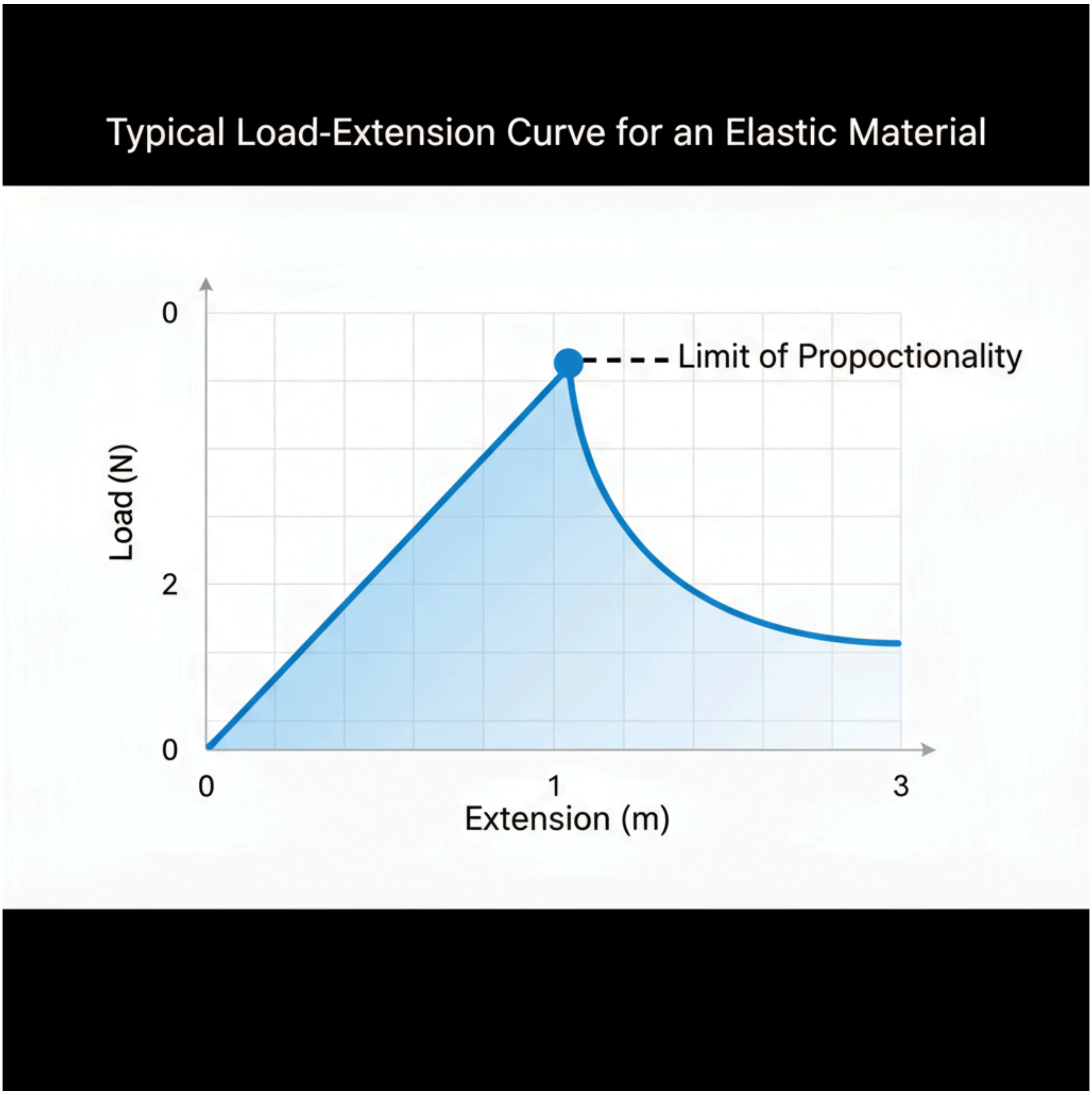
Effects of Forces

Forces can: * Change the speed of an object (acceleration or deceleration). * Change the direction of an object's motion. * Change the shape or size of an object (deformation).

Load-Extension Graphs

- For an elastic solid (like a spring), a load-extension graph typically shows a straight line through the origin, indicating proportionality (Hooke's Law). The gradient of this line is the spring constant.
- Beyond the limit of proportionality, the graph becomes curved, meaning the material will not return to its original shape once the force is removed (plastic

deformation).



Newton's Second Law

- **Formula:** $F = ma$ (where F = resultant force, m = mass, a = acceleration)
- This law states that the resultant force acting on an object is directly proportional to its mass and its acceleration. The force and acceleration are always in the same direction.

Worked Example: A 2 kg object is acted upon by a resultant force of 10 N. Calculate its acceleration. * F = 10 N * m = 2 kg * a = F/m = 10 N / 2 kg = 5 m/s^2

1.6 Momentum

Definitions

- **Momentum (p):** A measure of the inertia of a moving object, calculated as the product of its mass and velocity. It is a vector quantity. **Formula:** $p = mv$ (where m = mass, v = velocity)
- **Impulse:** The change in momentum of an object. It is also defined as the product of the force acting on an object and the time interval over which the force acts. **Formula:** Impulse = $F\Delta t = \Delta(mv)$

Conservation of Momentum

In a closed system, the total momentum before a collision or explosion is equal to the total momentum after the collision or explosion, provided no external forces act on the system.

Worked Example: A car of mass 1000 kg moving at 20 m/s collides with a stationary car of mass 1500 kg. After the collision, they move together. Calculate their common velocity. * Momentum before collision = $(1000kg \times 20m/s) + (1500kg \times 0m/s) = 20000kgm/s$ * Total mass after collision = $1000kg + 1500kg = 2500kg$ * Momentum after collision = $(2500kg \times v)$ * By conservation of momentum: $20000 = 2500 \times v \implies v = 20000/2500 = 8m/s$

Resultant Force and Momentum

Newton's Second Law can also be expressed in terms of momentum: the resultant force acting on an object is equal to the rate of change of its momentum.

Formula: $F = \Delta p/\Delta t$

1.7 Energy, work and power

1.7.1 Energy

Definitions

- **Energy:** The capacity to do work. It exists in various forms or 'stores' (kinetic, gravitational potential, chemical, elastic (strain), nuclear, electrostatic, internal (thermal)).

Energy Transfer

Energy can be transferred between these stores through processes like: * **Mechanical work done:** Transferring energy by forces (e.g., pushing an object). * **Electrical work done:** Transferring energy by electrical currents (e.g., in a circuit). * **Heating:** Transferring energy due to temperature differences. * **Waves:** Transferring energy via electromagnetic, sound, or other waves.

Formulas

- **Kinetic Energy (Ek):** Energy possessed by an object due to its motion. **Formula:** $E_k = 1/2mv^2$
- **Gravitational Potential Energy (Ep):** Energy stored in an object due to its position in a gravitational field. **Formula:** $\Delta E_p = mg\Delta h$

Conservation of Energy

- **Principle of Conservation of Energy:** Energy cannot be created or destroyed, only transferred from one form to another. The total energy in a closed system remains constant.

1.7.2 Work

Definitions

- **Work Done (W):** Energy transferred when a force causes a displacement. Mechanical or electrical work done is equal to the energy transferred.

Formulas

- **Mechanical Work Done (W): Formula:** $W = Fd = \Delta E$ (where F = force, d = distance moved in the direction of the force, ΔE = change in energy)

1.7.3 Energy resources

Types of Energy Resources

Useful energy can be obtained from various sources, including: * **Fossil fuels:** Chemical energy (e.g., coal, oil, natural gas). * **Biofuels:** Chemical energy from organic matter. * **Water:** Kinetic/potential energy from waves, tides, and hydroelectric dams. * **Geothermal:** Thermal energy from Earth's interior. * **Nuclear fuel:** Nuclear energy from fission (e.g., uranium). * **Solar energy:** Light from the Sun (solar cells for electricity) and infrared/electromagnetic waves (solar panels for heating water). * **Wind energy:** Kinetic energy of wind.

Many of these resources (except geothermal, nuclear, and tidal) ultimately derive their energy from the Sun.

Efficiency of Energy Transfer

- **Efficiency:** A measure of how much useful energy is produced from the total energy input. **Formula:**
    - $(\%) efficiency = (useful\ energy\ output / total\ energy\ input) \times 100\%$
    - $(\%) efficiency = (useful\ power\ output / total\ power\ input) \times 100\%$

1.7.4 Power

Definitions

- **Power (P):** The rate at which work is done or energy is transferred.

Formulas

- **Power (P):**
    - $P = W/t$ (where W = work done, t = time)
    - $P = \Delta E/t$ (where ΔE = energy transferred, t = time)

1.8 Pressure

Definitions

- **Pressure (p):** Force exerted per unit area. It is a scalar quantity. **Formula:** $p = F/A$ (where F = force, A = area)

Pressure in Liquids

- Pressure beneath the surface of a liquid increases with depth and the density of the liquid.
- **Change in Pressure (Δp): Formula:** $\Delta p = \rho g \Delta h$ (where ρ = density of liquid, g = gravitational field strength, Δh = change in depth)

Everyday Examples of Pressure

- **High pressure:** Sharp knives (small area, large pressure for cutting), high heels (small area, large pressure on the ground).
- **Low pressure:** Snowshoes (large area, small pressure to prevent sinking), wide tires on heavy vehicles (large area, small pressure on the road).

Key Terms & Definitions

Term	Definition
Scalar Quantity	A physical quantity that has magnitude only.
Vector Quantity	A physical quantity that has both magnitude and direction.
Speed	The rate at which an object covers distance.
Velocity	The rate at which an object changes its position, including both speed and direction.
Acceleration	The rate of change of velocity.
Deceleration	Negative acceleration; the object is slowing down.
Terminal Velocity	The constant speed that a freely falling object eventually reaches when air resistance prevents further acceleration.
Mass	A measure of the amount of matter in an object.
Weight	The gravitational force acting on an object due to its mass.
Gravitational Field Strength	Force per unit mass; equivalent to the acceleration of free fall.
Density	Mass per unit volume of a substance.
Force	A push or a pull that can change an object's motion, shape, or size.
Spring Constant	A measure of the stiffness of a spring, defined as the force per unit extension.
Limit of Proportionality	The point on a load-extension graph beyond which the extension is no longer directly proportional to the applied load.
Momentum	A measure of the inertia of a moving object, calculated as the product of its mass and velocity.
Impulse	The change in momentum of an object, or the product of force and time.
Energy	The capacity to do work.

Term	Definition
Kinetic Energy	Energy possessed by an object due to its motion.
Gravitational Potential Energy	Energy stored in an object due to its position in a gravitational field.
Work Done	Energy transferred when a force causes a displacement.
Efficiency	A measure of how much useful energy is produced from the total energy input.
Power	The rate at which work is done or energy is transferred.
Pressure	Force exerted per unit area.

Summary & Review

This study guide covered the fundamental concepts of motion, forces, and energy in IGCSE Physics. We explored scalar and vector quantities, different methods for measuring physical quantities, and how to interpret motion using distance-time and speed-time graphs. We also differentiated between mass and weight, defined density and its applications, and examined the effects of forces, including Hooke's Law and Newton's Second Law of Motion. Furthermore, we delved into momentum, the various forms and transfers of energy, the concepts of work and power, and the principles of pressure. Understanding these foundational principles is crucial for further study in physics.

Further Reading

- Save My Exams: IGCSE Physics - Motion, Forces & Energy
- Physics & Maths Tutor: IGCSE Physics Notes
- Khan Academy Physics
- Know that an object either remains at rest or continues in a straight line at constant speed unless acted on by a resultant force

- State that a resultant force may change the velocity of an object by changing its direction of motion or its speed
- Describe solid friction as the force between two surfaces that may impede motion and produce heating
- Know that friction (drag) acts on an object moving through a liquid
- Know that friction (drag) acts on an object moving through a gas (e.g. air resistance)
- Describe, qualitatively, motion in a circular path due to a force perpendicular to the motion as: (a) speed increases if force increases, with mass and radius constant, (b) radius decreases if force increases, with mass and speed constant, (c) an increased mass requires an increased force to keep speed and radius constant

1.5.2 Turning effect of forces

- Describe the moment of a force as a measure of its turning effect and give everyday examples
- Define the moment of a force as moment = force × perpendicular distance from the pivot; recall and use this equation
- Apply the principle of moments to situations with one force each side of the pivot, including balancing of a beam
- Apply the principle of moments to other situations, including those with more than one force each side of the pivot
- State that, when there is no resultant force and no resultant moment, an object is in equilibrium
- Describe an experiment to demonstrate that there is no resultant moment on an object in equilibrium

1.5.3 Centre of gravity

- State what is meant by centre of gravity
- Describe an experiment to determine the position of the centre of gravity of an irregularly shaped plane lamina

- Describe, qualitatively, the effect of the position of the centre of gravity on the stability of simple objects

1.5 Forces (continued)

1.5.1 Effects of forces

Newton's First Law of Motion

An object at rest will remain at rest, and an object in motion will remain in motion at a constant velocity (constant speed in a straight line) unless acted upon by a **resultant force**. This means that if there is no net force acting on an object, its state of motion will not change.

Resultant Force and Velocity Change

A resultant force acting on an object can change its velocity, either by altering its speed, its direction of motion, or both. For example, a force applied in the direction of motion will change its speed, while a force applied perpendicular to the motion will change its direction.

Friction and Drag

- **Solid Friction:** This is the force between two surfaces in contact that opposes relative motion or tends to oppose such motion. It can impede motion and produce heating (e.g., rubbing hands together).
- **Drag (Fluid Resistance):** This is the force that opposes the motion of an object through a fluid (liquid or gas).
  - **In liquids:** Friction (drag) acts on an object moving through a liquid (e.g., a submarine moving through water).
  - **In gases:** Friction (drag) acts on an object moving through a gas, commonly known as **air resistance** (e.g., a car moving through air).

Circular Motion

When an object moves in a circular path, there is always a force acting perpendicular to its direction of motion, directed towards the center of the circle. This force is called the **centripetal force**. Qualitatively: * If the centripetal force increases, the speed of the object increases (with mass and radius constant). * If the centripetal force increases, the radius of the circular path decreases (with mass and speed constant). *

An increased mass requires an increased centripetal force to maintain constant speed and radius.

1.5.2 Turning effect of forces (Moments)

Moment of a Force

The **moment of a force** (or torque) is a measure of its turning effect about a pivot. It is calculated as the product of the force and the perpendicular distance from the pivot to the line of action of the force.

Formula: $Moment = Force \times Perpendicular\ distance\ from\ pivot$

Units: Newton-metre (Nm)

Everyday Examples: Opening a door, using a spanner to tighten a nut, using a seesaw.

Principle of Moments

For an object to be in **equilibrium** (no resultant force and no resultant moment), the sum of the clockwise moments about any point must be equal to the sum of the anticlockwise moments about the same point.

Experiment to Demonstrate No Resultant Moment:

A simple experiment involves balancing a metre rule on a pivot. Place different masses at various distances from the pivot on both sides. When the rule is balanced horizontally, the total clockwise moment equals the total anticlockwise moment. If the rule is not balanced, there is a resultant moment, causing it to turn.

1.5.3 Centre of gravity

Definition:

The **centre of gravity** of an object is the single point where the entire weight of the object appears to act. For a symmetrical object with uniform density, the centre of gravity is at its geometric center.

Experiment to Determine Centre of Gravity of an Irregular Lamina:

1. Make three small holes near the edge of the irregular lamina.
2. Suspend the lamina freely from one of the holes using a pin or clamp stand.

3. Hang a plumb line (a string with a weight) from the same pin.
4. Once the lamina and plumb line have stopped swinging, draw a line along the plumb line on the lamina.
5. Repeat the process by suspending the lamina from the other two holes, drawing a line each time.
6. The point where all three lines intersect is the centre of gravity of the lamina.

Stability and Centre of Gravity

The position of the centre of gravity significantly affects the stability of an object: * **Stable Equilibrium:** An object is stable if, when tilted slightly, it returns to its original position. This occurs when the centre of gravity is low and the base area is wide. When tilted, the line of action of the weight falls within the base, creating a restoring moment. * **Unstable Equilibrium:** An object is unstable if, when tilted slightly, it topples over. This occurs when the centre of gravity is high and the base area is narrow. When tilted, the line of action of the weight falls outside the base, creating an overturning moment. * **Neutral Equilibrium:** An object is in neutral equilibrium if, when displaced, it remains in its new position. This occurs when the centre of gravity remains directly above the point of support (e.g., a ball on a flat surface).